Space Weather Technical Forecast

Issued on Wednesday, 01 March 2023 at 12:33 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Recent CME and HSS influences gradually easing on March 1st. Likely chance of M-flares, with slight chance of X-flares, primarily from AR3234. Active fluence expected to develop on Day 1 (1st Mar).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate, with an M8.6 flare observed at 28/1750 UTC, originating from AR3234 in the northwest quadrant, and a more recent M1 from the same region at 01/0107UTC. There are currently six sunspot regions on the visible disc, five are numbered, with a newly emerged unnumbered spot in the southeast quadrant. The largest region, AR3234, in the northwest quadrant is the most magnetically complex and contains a 'delta' spot. Other spot regions are relatively small and magnetically simple. An emerging region on the northeast limb could also reveal further complexity as it rotates further into view.

The M8.6 flare in the northwest produced a CME, which was modelled and shows a trajectory well ahead of Earth orbit. There have been no other Earth-directed CMEs observed in available imagery.

S**olar Wind / Geomagnetic Activity:** Solar winds have been mainly in the range 600-720km/s, largely due to a high speed stream (HSS) from CH79, which was initially masked by the recent CME effects. Density was below average. Total magnetic field strength was initially moderate, around 10nT, but soon decreased to weak levels, mostly around 6nT. The north-south component, Bz, varied between +10nT and -5nT. Phi angle has been predominately negative (towards the Sun). Geomagnetic activity was Quiet to Active (Kp 1 to 4).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16 has returned to background levels over the last 24 hours. Electron flux started at moderate levels, but exceeded the high level threshold late on the 28th, with a peak of 2.45e3 pfu at 01/1150UTC. Electron fluence has been on a steady rising trend, reaching 3.81e7 integrated pfu at 01/0000UTC, and more recently 9.74e7 integrated pfu at 01/1200UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is forecast through the period, mainly due to the large, complex region AR3234 in the northwest quadrant. An emerging sunspot region in the far northeast may also start to contribute to the flare risk.

Solar Wind / Geomagnetic Activity: Recent CME activity has declined, with speeds decreasing towards the background high speed stream speed of 500-600km/s. No further CMEs are forecast to affect the Earth. Solar winds are expected to gradually decrease during the next couple of days, eventually toward background levels as high speed stream influence wanes. Geomagnetic activity is forecast to start mainly Quiet to Unsettled, with a chance of Active intervals. Becoming mostly Quiet days 2 and 3 (02-03 March), although possibly becoming Quiet to Unsettled, with a slight chance of Active or G1/minor storm later on day 4 (04 March) due to

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potential HSS arriving from CH81/-.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 2MeV) is below the S1/Minor storm level with only a slight chance of rising above due to any significant flares that occur, primarily from AR3234 in the northwest. High energy electron flux (greater than 2MeV) is expected to rise through the period, persistently exceeding the high threshold especially on diurnal maximums. Electron fluence is expected to increase with an expectation of exceeding the Active (1e8 integrated pfu) threshold during Day 1 (1st Mar), and likely remaining at Active levels until later in the period.

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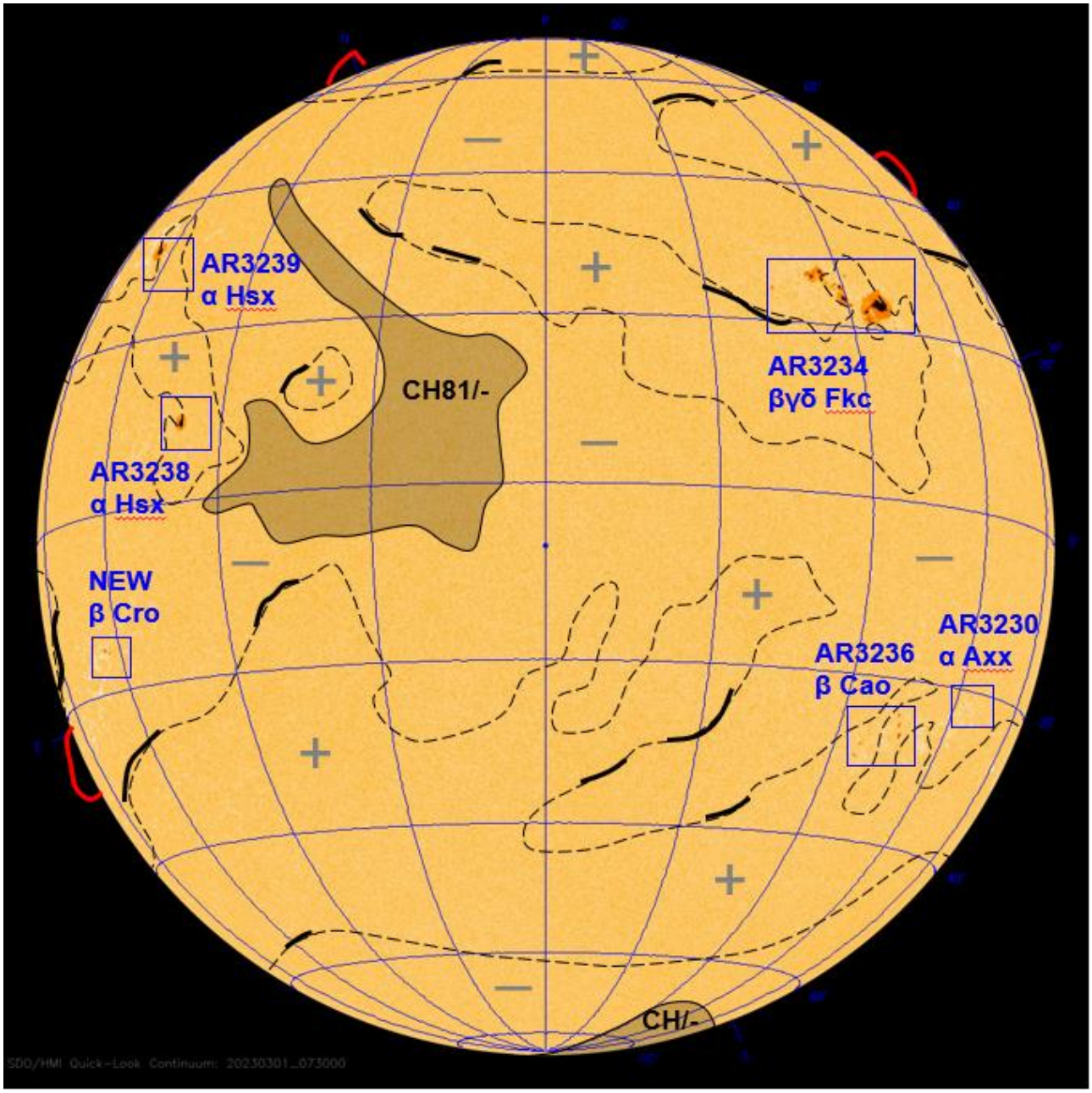
Figure 1. Solar Analysis Valid 01/0800UTC.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No further CMEs are currently forecast to arrive at Earth during the forecast period.
The high speed stream from coronal hole 79 continues connected to Earth, giving speeds close to 600km/s at present. This is expected to gradually decrease during the next couple of days, eventually toward background levels. A coronal hole in the north centre of the Sun may have been modelled by Enlil as affecting the Earth, but this appears unlikely to have significant effects, as the Earth is currently below the solar equator, with this hole well to the north.
A large coronal hole (CH81-) in the eastern hemisphere is likely to bring a high speed stream (HSS), which may arrive at Earth later on day 4 (04 March) or just beyond this forecast period (05 March).

Geomagnetic activity is expected to be mainly Quiet to Unsettled on 01 March, with a chance of an Active interval, especially at first. Trending mostly Quiet for the remainder of the period, although activity may increase to Unsettled or Active intervals later day 4 (04 March) due to the potential arrival of HSS from CH81/-, with a slight chance of a G1/minor storm.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	1	1	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

None expected.

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Radio Blackouts - X-Ray Flares:

There are currently six sunspot regions on the visible disc, with the risk of Moderate or Strong activity heavily biased towards AR3234 (Fkc/βγδ) in the northwest quadrant. This is a large region, with significant complexity, especially in the trailer region which contains a contorted delta spot. This region produced an M8.6 flare (R1/R2 Radio Blackouts) at 28/1750UTC, and a more recent M1 from the same region at 01/0107UTC, and is the most likely source of any further potential significant flares. Other spot regions are relatively small and magnetically simple. A new, and as yet numbered, region is emerging at the northeast limb. However, at present only the leading edge is visible and an initial analysis is not yet possible.
Solar activity is forecast be Low to Moderate, with a slight chance of isolated Strong flares.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 M Class**	Yes	65	60	50	50
Very Active	**R3 to R5 X Class**	No	20	20	15	10

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Solar Radiation Storms - (High Energy Protons):

High energy (greater than 10MeV) proton flux, as observed by GOES16 has been declining, and is expected to gradually fall towards background. AR3234 in the northwest quadrant has the potential to produce further significant flaring. This, alongside any other lower risk flare activity from the other regions on the disc brings slight chance of flux rates climbing again and reaching the S1 Minor Radiation storm threshold, especially as the large complex region is in a prime location for Earth-directed solar storms.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The recent CMEs and high speed stream are likely to have loaded the radiation belts with electrons. Initially these will have been displaced from the GEO orbit by the strong solar wind and increased geomagnetic activity. As the speed and activity eases, the electron flux has increased above the high threshold. The high energy electron flux (greater than 2MeV) is expected to be at largely high levels through the next couple of days, before a likely reducing trend later in the period.

Electron fluence values are forecast to increase with an expectation of exceeding the Active (1e8 integrated pfu) threshold during Day 1 (1st Mar), and likely remaining at Active levels until later in the period. This trend is supported by latest REFM data.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	90	90	80	50
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	10	10	10	5

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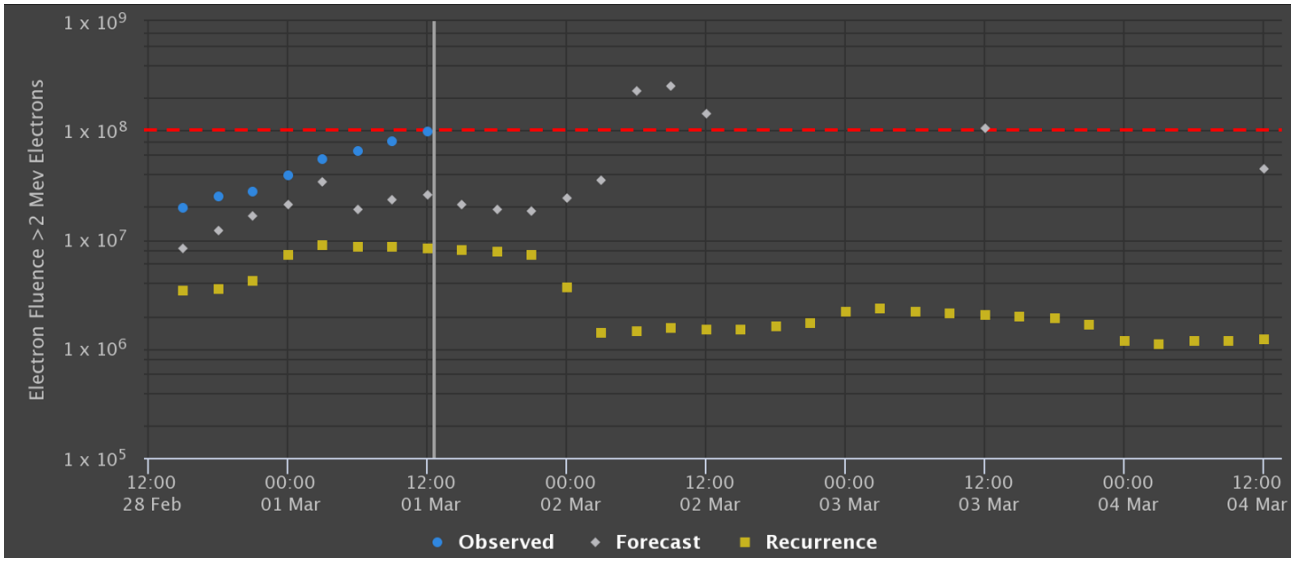
Figure 2: Latest MOSWOC REFM



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